HALEAKALA NATIONAL PARK CRATER DISTRICT RESOURCES BASIC INVENTORY: MOSSES OF THE CRATER DISTRICT

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The biological distinctiveness and the lack of serious bryological collecting in Hawaiian alpine areas was recognized as long ago as 1930. At that time Edwin B. Bartram, who would later publish the Manual of Hawaiian Mosses (1933), wrote to Otto Degener (dated September 30) and expressed the opinion that "The most likely places for new and interesting additions will be around the rim of Haleakala and above 6 or 7000 ft on Mauna Loa and Mauna Kea..." Since then, collections by Degener and others, primarily in conjunction with more generalized surveys, have tended to bear out these predictions.

The Resources Basic Inventory (RBI) surveys, conducted during the summers of 1975 through 1977, have provided an opportunity to study the moss flora of upper Haleakala as well as the distribution of the taxa. The intensive collecting in 55 representative sites has yielded what is probably a complete picture of the moss flora. With the taxonomic basis now understood, future research could include investigations of the moss communities present and their relationships to the general vegetation as well as physiological adaptations to the rigors of Hawaiian alpine conditions.

Identification of the mosses collected during the survey is virtually completed, and will result in a technical report summarizing the taxa present, their general distribution and phytogeographic relationships. It would perhaps be most appropriate at this time to summarize general relationships of the mosses of upper Haleakala and to discuss a few of the phytogeographically significant species.

Bartram, in introductory remarks to his Manual, concluded that the affinities of the Hawaiian moss flora lay almost exclusively with the region to the southwest, i.e., to the Indo-Pacific region. Gemmell (1955), in further analysis of Bartram's data, came to the same conclusion. Based upon the incomplete data then available, these conclusions were certainly correct. However, availability of more recent collections, particularly from the poorly-known Hawaiian alpine areas, has shown that the desert-like areas above the tree line contain a surprisingly large and diverse flora. The sometimes abundant representation of genera such as Andreaea, Encalypta, Grimmia, Ptychomitrium,

Racomitrium, and Tortula are not at all reminiscent of Indo-Malesian or even of tropical floras but of the northern and southern hemisphere temperate regions instead. The non-endemic species and close relationship of many of the endemics further suggest Boreal relationships. The purely Austral elements are, in fact, represented by only a few taxa. Table 1 summarizes the phytogeographic relationships of Haleakala's alpine species. Of the 36 taxa which can be identified with confidence, 15 (42%) are represented in both the North and South temperate areas, 13 (36%) are Boreal, with only 3 (8%) Austral. With the possible exception of three endemic species in the "unknown" category, there is no relationship with the Indo-Pacific floras. This suggestion should not be as surprising as it may first seem. In terms of dispersal distance the Hawaiian Islands are considerably closer to Boreal than to possible Indo-Pacific or Austral sources of diaspores for its alpine flora. Both the jet stream and the trade winds originate in the Boreal regions.

One may reasonably ask, then, about the origins of the three austral Haleakala taxa. Amphidium tortuosum, although widely distributed in the temperate Southern Hemisphere, seems to have migrated northward along the American cordilleras, reaching into Central America. The local populations, therefore, may well be descendent from American rather than Austral sources. Tortella fragilis var. tortelloides, originally described from Antarctica, both there and in Hawai'i may simply represent stress forms resulting in similar morphological responses rather than one being derived from the other. That is, the two populations are probably not the result of long distance dispersal. Andreaea acutifolia, known from such Austral areas as the Falkland Islands, Auckland Islands, Campbell Island, New Zealand, Kerguelen, and southern South America, is generally considered to be variable and very close to the extremely variable and cosmopolitan Andreaea rupestris. Whether it deserves specific or even varietal recognition is being investigated.

The Boreal representatives clearly outnumber the Austral (>4:1) in the Hawaiian alpine. The odds, then, would seem to favor Boreal origins for the majority of the mosses of cosmopolitan-temperate affinities. If this hypothesis is correct, then Haleakala's alpine flora is basically of Boreal origin and has little relationships with the downslope, primarily Indo-Pacific rain forest species.

The Crater District of Haleakala National Park is interesting to a bryologist not only because of its alpine flora but because it contains upper rain forest representatives in areas such as Paliku. Areas such as Paliku are, in many ways, clearly transitional. They serve as the upper boundary for the many taxa of the lowland forest which are only sparingly represented and as the lower limit for alpine taxa which are present only in exposed sites. There is, however, a surprisingly large number of Boreal forest elements present. New Maui or Hawaiian Islands records of this type discovered during the past three summers include

Isopterygium elegans, Plagiothecium cavifolium, Trichostomum tenuirostre, Leptodontium flexifolium and Orthodontium pellucens, among others. The first three are new state records, and may eventually be found on other islands as well.

The lower and middle Hawaiian rain forests are undoubtedly the best known regions bryologically. The mosses of such areas are often obvious and abundant. Historically, these forests have been the easiest of access. The phytogeograhpic affinities of these species generally lie with Oceania and SE Asia. In very simple terms, these species require all but brief periods of constant moisture and high humidity. They are probably also frost intolerant. Although the Paliku area is probably sufficiently wet for at least most of these rain forest taxa, the cold air draining from the Crater and the surrounding slopes may well represent the single most important factor in limiting their presence. The rain forest taxa will be discussed in the technical report; I would like to emphasize that they are only sparingly present and are never as abundant as they would be further downslope in rain forest areas.

The remnant dryland forest of eastern Kaupo Gap has a number of structural similarities with the dryland forest of the Wai'anae Mountains of O'ahu. Both have a well-developed canopy cover, with a nearly absent understory and herbaceous ground cover. Several moss species, common in the Wai'anae Mountains, in the Park are confined to the Kaupo Gap dry forests. These include Entodon solanderi and Fissidens intermedius.

In addition to the Boreal forest elements discussed and the locally attenuated lower and middle rain forest taxa, the Paliku area contains an upper rain forest montane element. This general habitat and associated species assemblage is found on all of the Hawaiian Islands between 4000 to 6000 feet. In the absence of quantitative data, about all that one can say is that there is a clear change in the genera and species which predominate when compared with the lowland forest. This difference is sufficiently marked to be noticed in the field by a person familiar with the lower forests. Unlike the alpine, in which Boreal representatives predominate, and the lowland-middle elevation forests in which the Indo-Malesian elements are the most important, the upper rain forest is comprised of species from American, continental Asian as well as Indo-Pacific sources.

These remarks on the mosses of Haleakala are clearly only introductory. They are intended primarily to point out the uniqueness and the value of the Crater District from a scientific as well as a resource management point of view and to encourage future studies. At this time, it is impossible to provide definitive answers to the questions this brief review must have raised.

LITERATURE CITED

Bartram, E. B. 1933. Manual of Hawaiian mosses. B. P. Bishop Museum Bull. 101, Honolulu. 275 pp.

Gemmell, A. R. 1955. A preliminary study of the Hawaiian moss flora. Mitt. Thur. Bot. Ges. 1: 71-86.

TABLE 1. Phytogeographic relationships of Haleakala's alpine moss flora. Taxa preceeded by an asterisk are considered endemic.

A. Cosmopolitan	B. Boreal
1. Andreaea rupestris	1. Amphidium lapponicum
2. Bartramia halleriana	* 2. Bartramia baldwinii
3. Brachythecium rutabulum	* 3. Brachythecium hawaiicum
4. Bryoerythrophyllum recurvirostre	4. Fabronia ciliaris
5. Desmatodon convolutus	5. Grimmia apocarpa var. pulvinata
* 6. Encalypta sandwicensis	6. Grimmia apocarpa var. stricta
* 7. Encalypta scabrata	7. Grimmia pilifera
* 8. Grimmia haleakalae	* 8. Grimmia scabrifolia
9. Grimmia laevigata	9. Grimmia torquata
10. Grimmia pulvinata	10. Orthotrichum diaphanum
11. Grimmia trichophylla	11. Plagiopus oederi
12. Pohlia cruda	12. Rhabdoweisia crispata
13. Polytrichum piliferum	13. Tortula alpina var. inermis
14. Saelania glaucescens	
15. Tortula princeps	

C. Austral	D. Unknown or Other
1. Amphidium tortuosum	* 1. Orthotrichum hawaiicum
2. Andreaea acutifolia	* 2. Pohlia baldwinii
3. Tortella fragilis var. tortelloides	* 3. Pohlia mauiensis
	* 4. Ptychomitrium mauiense (Central American)
	5. Bryum ceramiocarpum (Andean Venezuela)